

Bioethanol Production

Matthew Williams, Kalven Metz, Isaac Wilson,
Daniel Kang, and Kevin Kruger



Problem Definition

MuPor industries has designed and patented a novel rapid fermentation bead system that needs to be tested and proven for industrial applications. These beads have shown to be effective for bench-top scale fermentation and microbrewery purposes, but their full potential will likely require a specially designed fermenter tailored to the design of the beads.



Project Goal

To have a fully functional 150-300 gallon ethanol fermenter tailored specifically for the use of the BioEx beads and being capable of operating industrially.



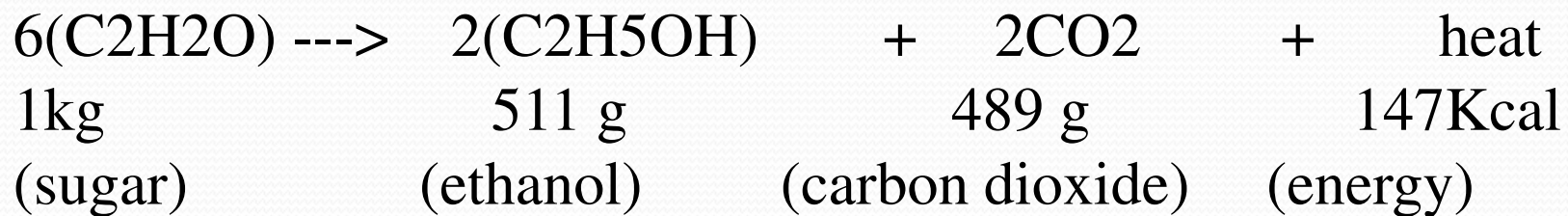
Major Parameters

- Temperature
- Sugar concentration
- Mass of beads per sugar solution
- Alcohol content
- Time

Current Design Specifications

Liquid Volume	150-300 gallons
Process	Batch or continuous flow reactor
Operating Temperature	70-100° F Optimal (95°)
Fermentation Time	2 hours
Initial Sugar Concentration	16% (yields 9.4% ethanol by volume)
Bead Loading	300 grams (Dry) Per Liter
Average Size	4mm
Composition Type	Encapsulated Matrix
Expansion	5.23 x dehydrated volume 33% expansion when actively fermenting

Gay-Lussac Equation



- Universal equation used to easily calculate byproducts from fermentation.
- Specifically we used it to calculate CO₂ evolved

Calculations: Determination of Theoretical CO₂

Per 18 gallons of 16% sugar solution (wt)

24.0336 lbs sugar x (453.592 grams/11lbs) = 10901.4 g sugar or 10.9014 kg sugar

Using stoichiometric relationship of reaction:

(.489 kg CO₂/1kg sugar) x (10.9014 kg sugar) = 5.33078 kg CO₂ produced

Converting to moles:

(5.33078 kg CO₂) x (1000 g/1 kg) x (1 mol/44.01 g) = 121.127 mol CO₂

Calculations cont.

Using ideal gas law $Pv = nRT$

$$P = 1 \text{ atm}$$

$$V = ?$$

$$R = .0821 \text{ L} \times \text{atm} / \text{mol K}$$

$$T = 273 \text{ K}$$

Solving for volume:

$$V = (121.127 \text{ mol} \times .0821 \text{ L atm/mol K} \times 273 \text{ K}) / 1 \text{ atm}$$

$$\underline{\underline{V = 2714.86 \text{ liters}}}$$

Experiment 1



- Beads migrated across the layers
- Head space (1.2 gallon loss)
- Loading and unloading overly complicated
- Reaction is exothermic ~ 6400 btu of heat per barrel reaction
- Dead zone at the bottom of the reaction vessel ~10 degree temperature change
- Had some initial problems with the set up of our reactor and were not able to get sufficient data collected